SHOCK EXPERIMENTS USING HOMESTAKE FORMATION AS AN ANALOG FOR THE CARBONATE IN METEORITE ALH 84001. C. S. Schwandt[1], F. Hörz[2], G. Haynes[1], and G. E. Lofgren[2], [1]Lockheed Martin Science Engineering Analysis and Test, 2400 NASA Road 1, Mail Code C23, Houston TX 77058, USA (Craig.S.Schwandt@jsc.nasa.gov), [2]Mail Code SN2, NASA Johnson Space Center, Houston TX 77058, USA.

Introduction: The origin of the carbonate within the meteorite ALH 84001 became an especially interesting petrologic puzzle since it was announced that the formation of carbonate involved biogenic processes on mars [1]. Alternative hypotheses for the formation of the carbonate have been presented [2–4], including the suggestion that the present carbonate occurrences crystallized from carbonate melt produced during impact on Mars [4]. As part of our experimental approach to examining mechanisms capable of forming and affecting carbonates similar to those in ALH 84001, we acquired samples of the Proterozoic (~1.9Ga) Homestake Formation (HF) for shock recovery experiments. The HF is a carbonate facies iron formation, most notable for its gold content. The HF is a good analog to ALH 84001 because it is a non-porous rock composed predominantly of siderite and ankerite, with minor quartz, orthoclase, albite, biotite, Fe-sulfides, rutile and Fe-oxides. The effects of shock on silicate rocks and minerals are well characterized [5] and serve as internal controls. Shock recovery experiments were conducted to pressures up to 65 GPa.

Experiments: Disks 7mm in diameter and 1mm thick were prepared from a sample of HF obtained from the U.S.G.S. The HF is very fine grained (<.5mm) and has an anhedral, granular texture. The rock is foliated with very fine scale laminations. Lighter colored lamina consist of interspersed siderite, ankerite, quartz, orthoclase, and albite. Darker lamina contain higher concentrations of anhedral interstitial biotite, sulfides, and oxides. The biotite is in various stages of the prograde reaction to orthoclase and Fe-oxide. The disks were prepared and shocked using a 20 mm powder propellant gun to accelerate flat flyer-plates [6]. Polished thin sections of the recovered coherent materials were prepared.

Results: Present data are from experiments at 0, 9.9, 31.2, 31.4, 31.5, 33.2, 34.4, 37.5, 39.3, and 51.2 GPa. The HF contains evidence of at least upper amphibolite facies regional metamorphism, as best expressed by the prograde conversion of biotite to orthoclase and iron oxide. It is important to note that the carbonates in the zero sample demonstrate no adverse effects from the thermal metamorphic event. The 9.9 GPa experiment shows very little change from the zero control sample, however, in the 31.2 GPa experiment biotite has started to decompose. Optically it is dark brown to black and opaque and in back-scattered electron imagery it is vesicluated and frothy. The carbonates perhaps show some mild additional fracturing, but they are not planar deformation features. In the 34.4 GPa experiment, the quartz and feldspar components have become isotropic, a higher percentage of the biotite has decomposed, and the carbonate is still relatively unaffected. The carbonate in the 39.3 GPa experiment shows some apparent decomposition to oxide, similar to the static pressure experiments of [7]. Most of the biotite has decomposed in the 51.2 GPa experiment. The carbonate shows more decomposition to oxide, but there is no evidence of carbonate melting. Two more experiments up to 65 GPa are in progress, but appear unlikely to produce carbonate melts.

Conclusions: We were unable to produce carbonate melts at pressures as high as 51 GPa, consistent with others [e.g. 8]. It is unlikely that the carbonate in the meteorite ALH 84001 has crystallized from shock produced melts.

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